

APPARATUS AND METHOD FOR CONTROLLING SWITCH OF SATELLITE
TRANSPOUNDER FOR MULTIBEAM COMMUNICATION

Technical Field

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The present invention relates to an apparatus for controlling a switch of a satellite transponder for multibeam communication and a method thereof; and, more particularly, to an apparatus for controlling a switch of a 10 satellite transponder for multibeam communication that can control an On Board Switch (OBS) of a communication satellite transponder which performs multibeam switching, and a method thereof.

15 Background Art

Generally, a communication satellite transponder which is mounted on a communication satellite in a geostationary orbit receives an uplink signal from an earth 20 station, converts the uplink signal into a downlink signal through signal conversion and amplification, and transmits the downlink signal back to the earth station. This function is called signal transponding.

The communication satellite transponder is called a 25 bent pipe-type transponder and it simply converts the frequency of the uplink signal inputted to the satellite, and amplifies and transmits the resultant signal.

Since the bent pipe-transponder has a simple structure, it is widely used for communication satellite transponding services. However, since a communication satellite signal wave is transmitted over a wide area, 5 there is a problem that the satellite wave output and frequency resources are used wastefully on the part of the earth station which performs one-to-one communication.

A prior art related to the present invention discloses "Time-space-time switching network adopted in 10 satellite" in Korean Patent Laid-Open No. 1994-001057 which is published on May 26, 1994.

The technology of the above prior art provides a T-S-T type switching circuit with improved reliability of the entire system by dividing a space switch having an $N \times N$ 15 switch structure in a conventional T-S-T type switching network, which is composed of a time switch of the receiving part-baseband space switch-time switch of the transmitting part in the On-board Baseband Processor (OBP) of a satellite communication system into, $N/m \times N/m'$ 20 switches. If there is only one space switch, trouble in the space switch leads to a serious trouble of the entire system. However, since the switch is divided into a plurality of space switches, although some of the space 25 switches are out of order, traffics can be processed with the other space switches. Therefore, the performance reliability can be increased.

However, the disclosed patent suggests only a method

of switching signal data transmitted from the satellite and increases the system reliability by switching data contents by demodulating signal transmitted to a satellite and converting the signal into data. In other words, it
5 receives uplink signals of the earth station transmitted from a plurality of beam areas in the satellite and transmits downlink signals into corresponding beam areas by switching electric wave signals in real-time. In consequences, it does not provide a function of
10 transmitting the electric wave signals which should be transmitted from a beam area into other areas in the satellite by using a switching function. Therefore, it cannot increase the electric power efficiency of the transponder and reuse frequencies.

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Disclosure of Invention

It is, therefore, an object of the present invention to provide an apparatus for controlling a switch of a
20 satellite transponder for multibeam communication, the apparatus which can increase the output efficiency of communicated satellite electric wave signals and reuse frequencies in one-to-one earth station communication or a one-to-multi earth station communication, and a method
25 thereof.

In accordance with one aspect of the present invention, there is provided an apparatus for controlling a switch of

a satellite transponder for multibeam communication, which will be referred to as a switch controlling apparatus herein, which includes: an earth control station interfacing block for receiving and processing commands from an earth control station, collecting operation states of the switch controlling apparatus and reporting the operation states to the earth control station; a reference frequency generating block for generating a reference clock needed to operate the switch controlling apparatus and generating a reference frequency needed for the operation of the switch controlling apparatus based on the reference clock; and a switch controlling block for reading contents of a memory that stores a switching sequence periodically, detecting and correcting an error of the contents to generate a switch control signal, and transmitting the switch control signal to a radio frequency (RF) switch.

In accordance with one aspect of the present invention, there is provided a method for controlling a switch which is applied to an apparatus for controlling a switch of a satellite transponder, the method which includes the steps of: a) receiving and processing commands from an earth control station, collecting operation states of the switch controlling apparatus and reporting the operation states to the earth control station; b) generating a reference clock needed to operate the switch controlling apparatus and generating a reference frequency needed for the operation of the switch controlling apparatus based on the reference

clock; and c) reading contents of a memory that stores a switching sequence periodically, detecting and correcting an error of the contents to generate a switch control signal, and transmitting the switch control signal to an RF
5 switch.

The present invention provides a communication satellite transponder that performs multibeam switching function with a concept of an On-Board Switch (OBS) satellite. Differently from a conventional bent pipe-type
10 satellite, the OBS satellite of the present invention divides communication coverage into several areas, e.g., an area A, an area B and an area C, and relays uplink and downlink signals from the areas to the satellite by performing beam switching in the satellite. Since satellite
15 signals are collected and transmitted according to each area differently from the conventional method where satellite signals are transmitted to the entire coverage areas, the output of satellite signals received in each area is higher than that of the signals in the conventional
20 bent pipe-type transponder. In addition, frequencies can be reused in each area due to the use of a multibeam.

Accordingly, the present invention provides a switch controlling apparatus which controls an RF switch for multibeam switching effectively. Its dual memory structure
25 increases system reliability and the switch controlling apparatus has an earth station interface for monitoring and controlling operation state of the switch controlling

apparatus in the earth station.

Brief Description of Drawings

5 The above and other objects and features of the present invention will become apparent from the following description of the preferred embodiments given in conjunction with the accompanying drawings, in which:

10 Fig. 1 is an exemplary diagram illustrating a satellite communication system for multibeam communication to which the present invention is applied;

15 Fig. 2 is a diagram describing a radio frequency (RF) switch, which is a Microwave Switch Matrix (MSM), and a switch controlling apparatus, which is a Digital Control Unit (DCU), mounted on an On-Board Switch (OBS) to which the present invention is applied; and

20 Fig. 3 is a block diagram describing a switch controlling apparatus of a satellite transponder for multibeam communication in accordance with an embodiment of the present invention.

Best Mode for Carrying Out the Invention

Other objects and aspects of the invention will become apparent from the following description of the embodiments with reference to the accompanying drawings, which is set forth hereinafter.

Fig. 1 is an exemplary diagram illustrating a satellite communication system for multibeam communication to which the present invention is applied.

As shown, an On-Board Switch (OBS) satellite 1000 divides satellite coverage where the electric waves from the satellite can be received into a plurality of areas. For example, an earth station 20 of an area A denotes one of earth stations that is located in a beam area A of the OBS satellite 1000. An earth station B 30 of an area B and an earth station C 30 of an area C denote earth stations that are located in the beam areas B and C of the OBS satellite 1000, respectively.

The earth station 20 of the area A transmits uplink signals to the OBS satellite 1000 by performing time-division on signals ($A \rightarrow B$ and $A \rightarrow C$) to be transmitted to an earth station in another area along with a signal ($A \rightarrow A$) to be transmitted to another earth station in the same area A.

The earth station 30 of the area B transmits uplink signals to the OBS satellite 1000 by performing time-division on signals ($B \rightarrow A$ and $B \rightarrow C$) to be transmitted to an earth station in another area along with a signal ($B \rightarrow B$) to be transmitted to another earth station in the same area B.

The earth station 40 of the area C transmits uplink signals to the OBS satellite 1000 by performing time-division on signals ($C \rightarrow A$ and $C \rightarrow B$) to be transmitted to an earth station in another area along with a signal ($C \rightarrow C$) to be transmitted to another earth station in the same area C.

The OBS satellite 1000 performs time-division switching on RF signals transmitted from the earth stations 20, 30 and 40 of the areas and classifies signals ($A \rightarrow A$, $B \rightarrow A$ and $C \rightarrow A$) to be transmitted to the area A as signals for the area A; signals ($A \rightarrow B$, $B \rightarrow B$ and $C \rightarrow B$) to be transmitted to the area B as signals for the area B; and signals ($A \rightarrow C$, $B \rightarrow C$ and $C \rightarrow C$) to be transmitted to the area C as signals for the area C.

The classified signals are transmitted as downlink signals for each area through a satellite antenna directed to each area. To sum up, the downlink signals for the area A are obtained by performing switching on the signals (black signals) that should be transmitted to the area A in the satellite and transmitted to the area A. The downlink signals for the area B are obtained by performing switching on the signals (white signals) that should be transmitted to the area B in the satellite and transmitted to the area B. The downlink signals for the area C are obtained by performing switching on the signals (signals expressed in block and white, i.e., black and white signals) that should be transmitted to the area C in the satellite and transmitted to the area C.

Fig. 2 is a diagram describing a radio frequency (RF) switch, which is a Microwave Switch Matrix (MSM), and a switch controller, which is a Digital Control Unit (DCU), mounted on an On-Board Switch (OBS) switch to which the present invention is applied.

As shown, the MSM 1100 performs switching on uplink signals A, B and C that are transmitted upwardly from an earth station, converts them into downlink signals a, b and c, and transmits them to the earth stations of the areas.

5 The operation of the MSM 1100 is controlled by the DCU 1200, which is a switch controlling apparatus. The DCU 1200 stores a switching sequence which is needed to control the MSM 1100 in a memory and controls the MSM 1100 by reading the sequence sequentially.

10 The DCU 1200 is interfaced with an earth control station 1300. It communicates with the earth control station 1300 through a Tracking, Telemetry & Command (TT&C) channel. Through the interface, the earth control station 1300 can monitor the operation of the DCU 1200 mounted on

15 the satellite and adjust various DCU operation parameters required for operation. Also, the DCU 1200 performs a function of updating the switching sequence stored in a switching memory 1221 of the DCU 1200 through the interface with the earth control station 1300.

20 Fig. 3 is a block diagram describing the DCU 1200 of a satellite transponder for multibeam communication in accordance with an embodiment of the present invention.

As shown, the DCU 1200 of the satellite transponder for multibeam communication, which is suggested in the

25 present invention, comprises a control station interface block 1210, a switch controlling block 1220, and a reference frequency generating block 1230.

The control station interface block 1210 receives and processes commands from the earth control station 1300, collects data on the operation state of the DCU 1200, and reports them to the earth control station 1300. The switch 5 controlling block 1220 reads the contents of the memory that stores the switching sequence periodically, detects and corrects an error in the contents to generate a switch control signal, and transmits the switch control signal to the RF switch 1100. The reference frequency generating 10 block 1230 generates a reference clock which is required for the operation of the DCU 1200 and generates a reference frequency required for the operation of the DCU 1200.

The switch controlling apparatus 1200 of a satellite transponder for multibeam communication having the above 15 structure, which is suggested in the present invention, is operated as follows.

The control station interface block 1210, which is a module in charge of interface between the DCU 1200 and the earth control station 1300, includes a controller 1211 and 20 a remote monitoring unit 1212.

The controller 1211 receives DCU control commands transmitted upwardly from the earth control station 1300, analyzes the commands and transmits them to corresponding parts of the DCU, i.e., switch controlling apparatus 1200.

25 The remote monitoring unit 1212 collects operation states of modules in the DCU 1200 periodically and transmits them to the earth control station 1300 so that

the operation state of the DCU 1200 can be monitored in the earth control station 1300.

The reference frequency generating block 1230 generates a clock and a synchronization signal required for 5 the operation of the DCU 1200, and it includes a reference clock generator 1231 and a reference frequency generator 1232. The reference clock generator 1231 includes a voltage control crystal oscillator (VCXO) that generates highly stable clocks and it has a function of receiving 10 frequency control data from the earth control station to correct phase difference from the clocks of the earth station. The reference frequency generator 1232 generates various synchronization signals required for the operation of the DCU 1200 by using the clocks generated in the 15 reference clock generator 1231. The synchronization signals are used to operate the DCU 1200.

The switch controlling block 1220 is a module in charge of switch controlling and it includes a switching memory 1221 and a memory interface unit 1222. The 20 switching memory 1221 is composed of two memories: A main memory and a preparatory memory. Even if the main memory is out of order, it can continue to be operated with the preparatory memory. The memory interface unit 1222 reads switching data stored in the switching memory 1221 and 25 writes updated switching data transmitted from the earth station in the switching memory 1221. A forward error correction (FEC) processor 1223 prevents an error in a

switching signal transmitted to the RF switch 1100, i.e., MSM, by correcting a memory content error generated due to radiation in the space environment. The FEC processor 1223 corrects a one-bit error among the memory data which are 5 read in the switching memory 1221. For errors more than two bits, it informs the presence of the errors to the earth station. Also, an output control 1224 transmits switching signals to the MSM 1100 and an operation frequency generator 1226 generates an operation time needed 10 to operate the switch controlling block 1220 by using the clock/synchronization signals generated in a reference frequency generating block 1230. A memory control unit 1225 controls the operation of the switching memory 1221 and the memory interface unit 1222 and synchronizes data 15 communication between them.

As described above, the RF switch controlling apparatus that is mounted on the OBS satellite for multibeam communication and performs beam switching on the uplink and downlink signals between the earth station and the satellite is new technology that can solve the problems 20 of the conventional communication satellite transponder, that is, a problem of low power efficiency of a satellite transponder and a problem of reusing frequencies, at once. Since it transmits signals for each communication area 25 collectively through real-time beam switching with a limited power of a transponder, the power efficiency in the satellite transponder is excellent. In addition, since

frequencies can be reused between isolated beams, the problem of insufficient frequency resources can be solved.

The method of the present invention, which is described above, can be embodied as a program and stored in a computer-readable recording medium such as CD-ROM, RAM, ROM, floppy disks, hard disks, magneto-optical disks and the like. Since the process can be easily executed by those of ordinary skill in the art of the present invention, further description on it will be omitted herein.

As described above, the dual memory structure suggested in the present invention can minimize the probability of system discontinuance caused by trouble in a memory during operation. Also, the switch controlling apparatus can control an RF switch stably by including the FEC function for correcting data errors that can be generated by radiation during the operation in the space environment. It also includes an earth station interface for monitoring and controlling the operation state of the DCU in the earth station.

Differently from the conventional communication satellite that relays signals by simply converting uplink signals into downlink signals through frequency conversion and amplification, the OBS satellite of the present invention performs multibeam communication converts and amplifies the frequency of the uplink signals from the earth station and, further, it performs beam switching on the signals transmitted from the earth stations and

transmits them downwardly to corresponding areas. This way, it can use satellite outputs efficiently and reuse frequencies by minimizing interference between the switched beams.

5 The present application contains subject matter related to Korean patent application No. 2003-0082239, filed in the Korean Intellectual Property Office on November 19, 2003, the entire contents of which is incorporated herein by reference.

10 While the present invention has been described with respect to certain preferred embodiments, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the scope of the invention as defined in the following claims.